

Project Title:

Three Dimensional Model for Equatorial Ionospheric Bubble

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Upwelling of lower-density plasma as the result of plasma instabilities creates plumes and bubbles in the equatorial ionosphere after sunset. (They also arise as a consequence of penetration electric fields during magnetic storms.) Plasma turbulence in the vicinity of these structures causes radio scintillation that interferes with communication and navigation (GPS) systems. These phenomena have been studied in the past in an idealized way, following the evolution of the plasma strictly in the equatorial plane in a two-dimensional model, using a static background ionosphere.

We have recently introduced a time-dependent background to the model, and allowed global-scale electric fields to be imposed, to better study the onset of the instability and its nonlinear evolution. We propose to generalize the model to three dimensions, including the variation along the geomagnetic field lines, to explore the structure of the bubbles.

With this model, we will be able to answer the important question of how far the bubbles extend in the north-south direction, and thus better estimate the volume of space occupied by these bubbles.

This work is relevant to several themes in the Living with a Star initiative, particularly the problem of geospace disturbances. A better understanding of the phenomena of equatorial bubbles is essential for predicting the impact of these phenomena on communication and navigation systems that rely on radio propagation through space.

The scientific understanding that follows will help us interpret the data from earlier NASA missions, e.g., San Marco, as well as upcoming missions such as CHAMP, the joint Air Force-NASA CNOFS mission, and the planned LWS GEC (Geospace Electrodynamic Connections) mission.

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